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XXIX.—*A case of Nerve Grafting*. By DAMER HARRISSON (introduced by Dr. HADDEN). *Read March 11, 1892.*

THE suture of nerves as a surgical procedure had a very fitful existence until 1878, when Gluck, of Berlin, published the results of his experiments upon fowls and rabbits, and proved that where apposition of divided nerves is perfect the degeneration of the distal end is slight, there being no axis-cylinders destitute of myeline to be seen, the axis-cylinders not being destroyed, and at the end of the fourteenth day the axis-cylinders, both in the cicatricial tissue and peripheral end, are to be seen, though without myeline, the ends of the nerves being connected by nerve-fibres destitute of myeline after eight days, and from this time a gradual formation of myeline sheath is to be observed, functional power being restored in the fowl in four days, and ten days after section of the vagus in the rabbit.

These observations gave further encouragement in the use of the suture, and from this time to the present the recorded cases in which the operation has been performed have rapidly accumulated.

In the *treatment* of those cases in which the resected nerve ends cannot be brought into apposition several methods have been advocated or tried; the only one, however, which has yet been attended with satisfactory results is that of nerve grafting. This was first suggested by the further experiments of Gluck (published in May, 1880), who grafted portions of the sciatic nerves of rabbits between the separated ends of the sciatic nerves of fowls, the conducting power of the nerves being restored by the end of the eleventh day. He dissected the nerve out eleven days after operation, and having isolated the nerve from the neighbouring tissues by means of a glass plate, he induced contractions in the muscles supplied by the nerve below the site of operation by irritation above that point.

The first surgeon to act upon the teaching of Gluck was Kaufman, in December, 1880, who grafted a portion of the sciatic nerve of a dog between the separated ends of the musculo-spiral without success.

The *second operation* was by Tillman in June, 1885, in a case of separation between the ends of both median and ulnar. Sensation returned at the end of four, motion at the end of nine weeks.

The *third case* was that of Dr. Gessung, of Vienna, in a case of recurrent neuromata at the point of division of the median into two branches, behind the annular ligament of the wrist.

The graft was from the sciatic nerve of a rabbit at its point of division, 6 centimetres in length, and this was sutured between the three ends of the median. Sensation began to return in two months. The result as to motion is not recorded; but one remarkable result of the operation was that no further tendency to neuromatous degeneration has since shown itself in the original nerve, which previously to this had repeatedly suffered from this disease.

The *fourth case* was Mr. Mayo Robson's in September, 1888 (and reported to this Society), for separation of nerve ends after excision of a neuroma of the median. The separation was 2 inches in extent. Forty-eight hours after the excision  $2\frac{1}{2}$  inches from the posterior tibial of an amputated limb was sutured between the separated ends. Sensation began to return in thirty-six hours; motion began to return in short abductor and flexor of the thumb in five weeks; functions completely returned in five months.

The *fifth case* was Mr. Ward's, of Leeds, in January, 1889. Separation after excision of neuroma of median,  $2\frac{1}{2}$  inches in length, taken from the median of an amputated arm. Sensation and motion were slow in returning; seventeen months elapsed before sensation could be localised. Trophic changes occurred; muscular wasting, glossy skin, bulla at the end of one finger. These gradually disappeared, and a fair amount of power returned to middle and index fingers, but abduction and opposition of the thumb remained lost.

The *sixth case* was another by Mr. Mayo Robson, in February, 1890. Two inches of spinal cord of a rabbit was sutured between the separated ends of the median in the upper arm. Sensation began to return in eleven days; motion of wrist and fingers began to return ten weeks afterwards, and became fairly good in five months; the ulnar, which had been sutured at the same time, did not recover.

The *seventh and eighth cases* were operated upon by Mr. Atkinson, of Leeds, in February and April, 1890, respectively.

The first of these two cases was one in which a portion of the sciatic nerve was accidentally removed during an operation of excision of the hip, but immediately replaced by suture. Sensation began to return in the toes on the fifth day, and could be localised in any part by the fifteenth day. The condition as to motion was not recorded, but only six months had elapsed when the case was reported.

The *second of these cases* was one of separation of ends of the ulnar in the forearm, 2 inches in length. A graft  $2\frac{1}{2}$  inches was taken from each sciatic nerve of a rabbit, the two grafts being fixed in position side by side. Sensation began to return on the eighteenth day in the ring and little fingers, and was completely restored in three months, except in the two last phalanges of the little finger. In three months the patient could flex all the fingers on the palm except the little finger, which stopped short by  $\frac{1}{4}$  an inch.

The *ninth case*, which is my own, was that of a boy aged 13, who was admitted into the Liverpool Northern Hospital on the 4th of June, 1891, with the following history:—Eleven weeks previously, while at work in some glass works at St. Helen's, a large plate of glass fell upon the front of the right wrist, dividing the median nerve and all the long flexors, except the flexor carpi ulnaris. The doctor who first attended to the case sutured the divided structures and bandaged the hand and fingers in a flexed position. The healing of the wound was attended with suppuration and some sloughing. Upon admission into the Liverpool Northern Hospital the fingers of the right hand were found to be in an immoveable flexed position, paralysis, both of sensation and motion, being complete, corresponding to the distribution of the median nerve. *Trophic changes* were also present, the hand being blue and cold, the skin glossy, and the short muscles of the thumb extremely atrophied.

*Upon the site* of the original injury being explored the flexor tendons were found to be matted together by cicatricial tissue.

The flexor sublimis digitorum could not be found, and nearly 2 inches of the median nerve had been destroyed, leaving a separation between the ends to this extent.

The flexor tendons were dissected from each other and from surrounding adhesions. The ends of the median nerve were then freshened—which increased the separation to fully 2 inches—and a graft  $2\frac{1}{2}$  inches in length taken from the sciatic nerve of a recently killed kitten was fixed in position

by one fine catgut suture at each end, which passed through the substance of the nerve.

The fingers were straightened, and the hand and forearm fixed upon a posterior rectangular splint, the hand being flexed, but the fingers kept in a straight position.

The after progress of the case was as follows :

The wound healed by first intention. *Sensibility* to the prick of a pin began to return to the palm of the hand and over the first phalanx of the thumb at the end of forty-eight hours, and soon afterwards (third day) became extended to the areas over the first phalanges of the index and middle fingers and the terminal phalanx of the thumb, and, eventually, over the middle phalanges of the index and middle fingers.

Sensation is still impaired over the middle phalanges and the first portion of the terminal phalanges of the fingers, but has not returned in the tips of the fingers. There is also transference of sensation present, sensation over the first phalanx of the index finger being referred to the corresponding area of the middle finger.

*The nutrition of the hand* became much improved by the end of two and a half to three months after operation; the glossiness and blue colour of the skin disappearing; the surface becoming nearly as warm as the left hand, unless exposed to cold, and a greater fulness and thickening becoming apparent over the short muscles of the thumb. *Motion* showed no signs of returning until the end of five months, when slight voluntary movement was observed in the short muscles of the thumb. These movements are still feeble more than eight months after the operation, but have much improved during the last three months, and the patient can now oppose the thumb to the index finger, good movement being present in the abductor pollicis. The flexion of the fingers upon the palm is not perfect, owing probably to the destruction of the flexor sublimis digitorum.

*The tenth and last case* is one recently performed by Mr. Mitchell Banks, of Liverpool, upon the ulnar nerve at the elbow, after incision of a neuromatous tumour, 4 inches being grafted from the sciatic nerve of a dog. Sensation is said by the patient to have returned in thirty-six hours.

This small number of cases is, of course, too few to generalise from; but, so far, the results are as follows:—Of the ten cases three have been perfectly successful, six partially successful, and only one failure.

Of the six partially successful cases four have made no

recovery as to motion, but of these one has not been yet sufficiently long under observation.

Of the remaining two, one (which is my own case) has been under observation only nine months, and is still improving.

All these cases, with the exception of my own, were cases of primary grafting, and it is among these—as in the case of primary simple suture of nerves—that return of complete motor function is the most rapid, the shortest time being five months.

In my case of secondary nerve grafting (eleven weeks after injury) the motor functions are not yet completely returned nine months after operation, but are still improving, and may go on doing so to complete restoration during the next year or two, as in the case of *secondary* simple suture.

This difference between the two kinds of cases appears to me to be mainly due to the trophic disturbances which are present when grafting or simple suture is performed as a secondary operation. The degenerated muscles must require a considerable time before they can be remade, although nerve continuity may have been rapidly established.

In none of the successful cases of primary simple suture, or primary nerve grafting, are trophic changes mentioned; and in two successful cases of my own, of simple suture of the median, no such changes appeared.

This evidence seems to prove the correctness of Gluck's observations that primary suture prevents any but very slight degeneration in the distal end of the nerve.

The cases in which symptoms of motor power are longest delayed in the case of simple secondary suture are those which have been operated upon from one to six months after injury, being the period during which the distal end of the nerve is in the extreme condition of degeneration.

This, however, only applies to motion, sensation, even in these cases, often returning in thirty-six to forty-eight hours, some axis-cylinders (probably of the sensory fibres) never being destroyed, but retaining their power of conduction, either by way of a loop line (through the interlacement of nerve-fibres) or by the restored continuity in the nerve.

In the latter case sensation must be conveyed by nerve-cells at the point of suture, and not by axis-cylinders, and it is difficult to understand how accurate localisation (such as is seen in some cases) can be conveyed in this way.

On the other hand, the loop line theory quite fails to explain

those cases of secondary suture which have shown no return of sensation, even many months after injury, until the nerve ends are freshened and sutured together. It has been suggested to me that the operation sets up a condition of excitability in the nerve that starts the loop line ; but, if this could be so, how is it that the original injury sometimes inflicted under similar conditions does not have the same effect, the function of sensation being in abeyance for months and years until the operation of suture or grafting is performed ?

May it be due to a combination of these factors, namely, the increased excitability in the nerve assisting in the conveyance of an impulse along both the loop line and the nerve, at the point of suture, at the same time, and in this way giving rise to localised sensation ?

*One further point* of interest in these cases is that a nerve may sufficiently recover to conduct sensation and influence nutrition without regaining its motor power. *This* is partially to be observed in Mr. Ward's case of nerve grafting, but is better illustrated by a case of simple suture of Mr. Weir's, and another of Mr. Ashhurst of America.

In both the sciatic was the nerve sutured, in the one nine years, in the other three months after injury. In both cases there was a total loss of sensation and motion, and trophic ulcerations over the foot. Sensation returned, all the trophic changes disappeared, but motor paralysis remained.

In conclusion, I think that the recorded cases of nerve grafting, although few in number, are encouraging, and give us fair ground for hope that this operation will be soon established as another useful resource in surgical procedure.